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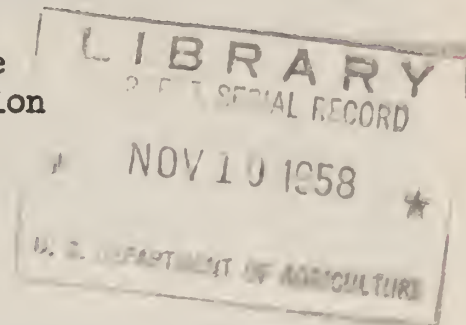
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Recent Developments for the Improvement of Livestock  
Through Breeding in the United States <sup>1/</sup>

Prepared by Specialists in the  
Animal Husbandry Research Division



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Dairy Cattle

Dairy cattle breeders in the United States have been primarily concerned during the past several years with adjustments to the impact of artificial insemination, market changes and new research findings. More than six million cows in the United States were bred by organized artificial breeding units last year, an increase of 5 percent over the previous year and 411 percent over 1947. As much as 47 percent of the registrations in one of the major breeds involved cattle resulting from artificial breeding. Purebred bull registrations and transfers have dropped markedly. On the other hand, the demand and prices paid for bulls meeting the qualifications of artificial breeding organizations have increased greatly. With a few exceptions, breeders recognize these developments as unavoidable and many consider that they have promise of promoting progress.

The changing of market demands has influenced the thinking of breeders more than it has the pricing structure of the markets. Breeders recognize that butter no longer monopolizes the table fat market. Nearly all breed associations today are giving added importance to milk yield in their selection efforts. All are interested in initiating selection for solids other than fat in the milk. However, most of the markets today still pay on a basis which favors high fat content and relatively few consider solids-not-fat in their pricing formulas.

The need for research facts has been emphasized by the efforts to make adjustments to changing markets and also artificial insemination. Studies on the genetic relationship between milk yield and butterfat content have shown that high test breeds could increase the milk yield of their cattle by selection for milk flow alone without reducing the butterfat content below anticipated market requirements. Other than a gross indication that solids-not-fat are inherited, adequate information on the genetics of these constituents is not available. A rapid, convenient and accurate technique for measuring the content of solids-not-fat, using the Watson lactometric method, has finally made this badly needed research possible. Within 3 to 5 years the basic facts needed for the guidance of breeders on selection for solids should be obtained. Efforts are also being intensified to test rapid methods of analysis for protein.

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<sup>1/</sup> Paper presented by R. E. McDowell at the Fourth Inter-American Meeting on Livestock Production held July 1958 at Kingston, Jamaica, B.W.I.



In addition to the research on selection for milk and the various constituents, scientists have been actively interested in studies on the genetics of mastitis, breeding efficiency, rate of milking, feed efficiency, forage utilization and adaptability. Extensive studies have been made on the relation of dairy type and production. Analyses on large amounts of data show there is a very small positive correlation between annual milk or butterfat yield and type as evaluated in breed classification programs. The relationship of type to longevity remains unexplored. However, the value of type in merchandizing cattle is great. This may be lessened as the facts regarding type's relationship to production become generally accepted.

Physical characteristics, in addition to the usual type components which have been given particular attention in recent years are lethals, anomalies and those color characteristics which bar registration. Increased efforts regarding control of these characteristics primarily involve methods of identifying carriers through improving information on incidence. No breeding methods for identifying carriers have been initiated in an organized manner.

Artificial insemination has greatly increased the demand for progeny tested sires. The superior reliability of the progeny test as compared to pedigree estimates of breeding value has been confirmed. Recent research results have challenged the value of a single herd proof in estimating a sire's merit when used in the artificial breeding industry. As a consequence of intensified investigations to determine the optimum method of evaluating sires for use in artificial breeding, considerable attention has been given to comparisons of the production records of a sire's daughters with the records of other cows in the same herd and made in the same year and season. Indications are that this procedure has real merit.

The demand for proved sires has revealed a real and pressing need for reliable methods of selecting, sampling and progeny testing of young sires. Organized artificial breeding units are using a wide range of differing efforts to obtain and test young bulls. Some are obtaining them through selective matings; others select them from outstanding cows of patrons; still others purchase them outright from outstanding breeding herds in all parts of the country. Young sires are being tested by sampling on the entire artificial breeding membership, on selected herds, and there is some interest in progeny testing stations such as in Denmark. No one has sufficient evidence to prove which method is most adequate.

Outbreeding continues to be the main mating system used for herd improvement. There is considerable interest in crossbreeding but most dairymen believe there are critical questions still unanswered about the use of this system and consequently are awaiting the results of research



now in progress before deciding on the merits of crossbreeding. Line-breeding to hold genetic gains while outcrossing to make still further improvement is the principal manner in which inbreeding is being utilized by progressive breeders. The availability of outstanding bulls through the use of frozen semen has decreased the dependence of some purebred breeders on following particular family lines.

Production testing of dairy cattle as conducted through the National Cooperative Dairy Herd Improvement Program is experiencing two major developments. One is the diversification of testing services to include nation-wide promotion of owner-sampler testing for both milk and butterfat and also weigh-a-day-a-month which evaluates production records on milk weights alone. As a result of these additional efforts 2,118,374 cows were reported on test January 1, 1958. The other development in production testing is machine records processing, which is being developed to eliminate arithmetic computation of records on the farm and to give dairymen more accurate production and management information. It is estimated that these procedures will be in partial use by at least 25 States during the next year.

Type classification has received considerable emphasis in breed association programs. Routine herd classifications are increasing in number in nearly all breeds. Methods for recognizing superior animals regarding production and type characteristics are in existence or are being planned in most breeds. Selective registration based on type characteristics is optional in one breed. Provisions for carefully restricted open herd books have been adopted by two of the associations.

At present the dairy cattle breeding industry in the United States is alive with a ferment of ideas prodded into being by developments in artificial breeding, market changes and research results. With an encouraging small number of exceptions, the attitude of persons concerned is that the changes and developments are opportunities for real progress. There is a healthy respect and demand for research facts to evaluate newly proposed breeding practices. The exaggerated optimism for sensational improvement through artificial breeding has practically disappeared. Most dairymen are fully aware that genetic improvement comes slowly and only with persistent and intelligent effort.

### Beef Cattle

An increasingly significant volume of results have been coming in during recent years from the cooperative beef cattle breeding research projects of the U. S. Department of Agriculture and State experiment stations.



Heritability estimates for most economically important traits have now been made in several herds and the averages of the estimates indicate what can be expected in general of beef cattle under U. S. conditions. Approximate averages of the estimates for several important traits are: birth weight, 40; weaning weight, 30; weaning conformation score, 30; maternal ability of cows, 40; postweaning gain on pasture, 30 and in feedlot, 45; efficiency of feed utilization, 40; slaughter grade, 40; area of rib eye, 70; and tenderness, 35-60. These estimates indicate that selection should be effective for most of these traits and they serve as a partial basis for the performance testing programs to be discussed below. Two experiments in which fast and slow gaining bulls were progeny tested on random groups of cows have demonstrated differences in gaining ability in the progeny.

A limited amount of data indicate that heritability of reproductive rate is low - perhaps near zero. Thus, the attention which should be given to it in a breeding program is uncertain. It should be recognized that there is continuous natural selection for fertility.

One study has indicated a possible genetic antagonism between weaning weight and post-weaning gaining ability, i.e., it suggests that cows with better than average maternal abilities may produce calves with less than average growing ability and vice versa. Additional studies are in progress aimed at getting better estimates of genetic parameters.

Several tests are in progress in which lines or strains of cattle which have been intensively selected for performance traits for a number of years are being tested in top crosses and the progeny performance compared with that of other stock. Only preliminary results are available as yet, but, in general, performance of the offspring of selected strains and lines has been promising.

Data from several stations strongly suggest that selection is improving the performing ability within breed or strain. The improvement in gaining ability of the Brahman as compared to other breeds has been especially noteworthy at three different locations.

Inbreeding experiments are still in early stages at most stations but to-date it appears that, in common with other species, productivity declines with inbreeding but that lines can in some cases be successfully carried to fairly high inbreeding levels. Crosses of inbred lines and use of inbred sires in top crosses have given promising results to date, but it is still very uncertain whether enough advantage will be obtained from crosses of inbreds to pay for the very great expense of developing them.

Crossbreeding studies involving crosses among the three British breeds - Hereford, Angus and Shorthorn - have given conflicting results. Three new experiments are underway which should provide information on the amount of hybrid vigor, if any, to be obtained from such crosses.



Additional work in the Southern States has confirmed earlier results in indicating definite heterotic effects of crossing Brahman and British type cattle. The hybrid vigor is important enough to encourage the use of crossing programs using these types of cattle in commercial production in that area.

The heritability of carcass traits is being studied at a number of locations as are the questions of the relations of various live animal and carcass traits to eating quality of the meat. This work indicates that tenderness is a character preferred by the majority of consumers and that it has a heritable basis. Attempts are being made to devise tests for evaluating tenderness and other potential carcass traits in live animals in order that selection can be made for them directly rather than through the slow and costly progeny test process.

Performance testing procedures developed for beef cattle as a result of research on the subject usually include the following items: birth weight, weaning weight, weaning conformation score, post-weaning gain and conformation at market age. These records are used to evaluate the performance of the individual and also, in the case of weanling traits, to evaluate the mothering ability of the dam. Certain adjustments are necessary if the production records are to be most effectively used in selection. These include adjustment for sex and age of dam.

New breeds or breeds unusual in the United States including the Santa Gertrudis, Brangus, Charollaise and Charbray are being studied at experiment stations in the South. In general, all of these new or unusual breeds have proved to have excellent average gaining ability and general productivity. Some data indicate that in some cases there may be slight deficiencies in carcass quality, at least in their ability to meet U. S. carcass grade standards.

Thirty-three States now have organized programs in performance testing of beef cattle. In 8 of these States breeder organizations are carrying on this work and 6 of the State organizations are affiliated with a national organization - Performance Registry International - which was organized in 1955 under the name American Beef Cattle Performance Registry Association. Although as yet including only an infinitesimal fraction of the nation's beef cattle these programs have been growing by leaps and bounds the past three years and in 1957 included about 1,440 herds.

Recent developments in semen preservation and storage, particularly the preservation of semen through freezing, are known to have stimulated the use of artificial insemination. It is now widely used in a great many pedigree herds as a disease control measure, through artificial breeding centers to make wider use of high quality bulls and in commercial herds to increase the use of quality sires.



### Sheep

Investigation of various systems of breeding has been continued at the U. S. Sheep Experiment Station, Dubois, Idaho, for many years. Systems of breeding being compared at Dubois include the development and crossing of inbred lines and the development of selected non-inbred groups. Inbred lines when crossed show improvement over parent lines and inbred sires are performing well in top crosses. However, the average of all crosses made do not generally excel the selected non-inbred groups. It seems probable that crosses from only the most promising lines may compare favorably with the selected groups.

Selection appears to be the most practical means of obtaining immediate improvement in sheep. Selection procedures can be applied to any type of operation. Factors which have been shown to be important in making rapid progress from selection include attention to the smallest number of economically important traits than tend to be improved most rapidly; selection of rams, rapid turnover of generations, accounting for environmental effects, and the keeping of accurate records.

The difficulty of visually determining the rank of desirable characteristics has led to the development of mechanical aids upon which selection is based. A notable, recent development involves estimating the clean fleece weight of wool at the time of shearing. The use of this machine, based on the volume of wool at a constant pressure, increases the accuracy and accelerates the process of selecting sheep of high producing ability for clean wool.

Crossbreeding of the mutton breeds (Hampshire, Shropshire and South-down) for fat lamb production at the USDA, ARC, Beltsville, Maryland, has shown that specific gains can be made in the crossbred progeny over the average of the parent breeds. Lamb mortality is reduced about a fourth in the two-breed and about a third in the three-breed crosses. The number of lambs weaned has increased about 10 percent with both kinds of crosses. Weight of lambs weaned has increased about 11 pounds for the two-breed crosses and about 18 pounds for the three-breed crosses. Fleece weight has increased about 25 percent for two-breed crosses and 28 percent in the three-breed crosses. Ewe productivity, as measured by an index, has increased about 13 percent for two-breed crosses and 23 percent for three-breed crosses. Incorporation of Merino fine-wool breeding into two-, three- and four-breed crosses has also resulted in similar increases.

Many States have initiated studies on the breeding behavior of sheep with the intention of securing breeds or lines of sheep that will lamb early enough to insure the fat lamb to be ready at the peak of market (April-June). Work at Alabama indicates that ewes born early will also tend to produce lambs earlier. There is also an indication that crossbred ewes will excel purebred ewes in earlier lambing. Definite breed differences were found with respect to early lambing, with the Rambouillet generally being superior to mutton breeds.



Only limited information is available on the possibility of improving efficiency of gain in sheep through breeding. Tests of rams from various breeders in Texas and in Utah show that animals vary in ability to gain efficiently within as well as between various breeding groups. The finding that feed requirements per unit increase in weight are fairly high indicates that further work is necessary in determining the optimum ratio of roughage to concentrate in the test ration. The U. S. Sheep Experiment Station, Dubois, Idaho, has initiated performance tests in which the ration is predominantly roughage, while the University of Idaho is using a high concentrate ration. Although the tests have not progressed to the stage where the performance of progeny from the first rams tested are available, both tests show rather wide differences between rams in ability to gain and to utilize feed efficiently.

Ram performance trials in Texas over a 10-year period have shown improvement in average daily gain from .37 to .60 pound per day, from 6.6 to 9.3 pounds of clean wool and from 3.4 to 4.2 inches in staple length. Improvement trends were not noted for face covering or skin folds.

Work in development of new breeds of sheep is being conducted at a number of places. An example is the combination of the Columbia, Dorset and Cheviot breeds which is hoped to excel current white-face breeds in mutton and wool production characteristics under an environment common to Western Oregon. The Columbia x Southdale strain currently undergoing development at Beltsville, Maryland, and Middlebury, Vermont, is another example. However, many years of selection may be required before these strains will be recognized as useful breeds.

Experiments in South Carolina and New Mexico show reasonable, although not always consistent, results with artificial insemination of sheep. Ram semen appears to lose fertility rather quickly on storage and does not appear to retain fertility when stored frozen.

Improvement of sheep through breeding is limited by factors which tend to limit or reduce the differences which can be obtained by selection. Most farm flocks and many range flocks are too small to permit effective selection within flocks. Those breeders who purchase sires are usually unable to make any accounting for environmental differences among rams available for purchase. Many production traits cannot be measured in young animals where it is economically desirable to do most of the culling. Show ring standards and breed standards are often inconsistent with productivity under practical conditions so that selection is practiced for traits which do not lead to more efficient production of lambs or wool. One of the most serious limitations to progress is the inability to define lamb meat quality and to measure it in the live animal.



### Swine

A significant development pertaining to the improvement of swine in the United States in recent years was the establishment in 1937 of the Regional Swine Breeding Laboratory with headquarters at Ames, Iowa. There are now 10 State experiment stations collaborating with breeding projects related to the cooperative effort. Experiments are in progress in the Laboratory concerning methods of selection, use of inbreeding with selection within and between lines and breeds, testing of lines for crossing within and between breeds, the comparative performance of lines and line crosses under various kinds of environment, ovulation rate and embryonic losses in various breeding groups and desirability of carcasses. Approximately 2,000 litters were produced last year for studies relating to the above problems.

Most of the experimental swine breeding work being conducted at the various State agricultural experiment stations and the USDA centers on estimating the heritability of different economic traits; constructing selection indexes which will maximize the genetic gain expected to result from selection, estimating genetic correlations among traits which may be antagonistic to each other and thus limit the progress obtainable from selection, designing breeding programs which will enhance and further exploit the hybrid vigor which usually results from crossbreeding; and developing more adequate methods of identifying animals possessing superior germ plasm than are now available.

Considerable emphasis is also being placed on developing methods to improve selection procedures, particularly for improving carcass quality. Two methods have proven valuable and are being used extensively by breeders in locating superior meat type breeding stock. The probing techniques developed by Hazel and Kline in 1951 at the Iowa Station involve the making of small incisions with a scalpel through the skin at various locations over the pig's back and pressing a small metal ruler through the layer of fat to the firm tissue underneath. The lean meter, developed by Andrews and Whaley at Purdue University in 1954, is an electrical device which makes use of the difference in electric conductivity which normally exists between fat and lean tissues.

Performance tests intended to enhance the accuracy of selection above that based simply on appraisal of the animal's type and conformation are receiving increased attention. In some States testing stations have been established for feeding out boars and measuring their backfat to determine as precisely as possible what can be expected from the use of boars from such sources. At the Iowa Swine Testing Station every breeder enrolled in the program is entitled to enter three boars and one barrow by one sire and out of at least three litters. Growth rate and feed efficiency are recorded for each group and carcass data are obtained on the barrows. All boars which fail to meet the specified standards with respect to growth rate, feed efficiency and backfat thickness are castrated, while boars meeting these standards are either sold at auction or are kept by breeders for use in their own herds.



Performance testing programs being conducted by the several breed associations of purebred swine provide that both gilts and older sows must raise at least two litters of eight or more pigs each to a 56-day litter weight of at least 125 kilos for gilt litters and 145 kilos for sow litters in order to be admitted in the production registry. A program directed primarily at the efficient production of meat type swine has recently been added and a single set of rules adopted in 1956 by all of the major breed associations now provides for the certification of litters meeting the following standards: 1) The litter must qualify for production registry in accordance with the rules of the respective breed association; 2) Two pigs from the litter must have 180-day equivalent weights of at least 90 kilos; and 3) The same two pigs must be slaughtered at a live weight of 82-104 kilos and their carcasses must meet certain standards for loin eye muscle area at 10th rib, carcass length and back-fat thickness. All test pigs must be weighed and slaughtered at approved slaughter stations. Boars are given recognition as certified sires if they sire at least 5 certified litters and the dams are not too closely related.

At the Third Inter-American Meeting on Livestock Production, reference was made to the development of several new breeds of swine from hybrid foundations of Danish Landrace and other breeds of American origin. In addition to the six breeds mentioned at that meeting, two new breeds have recently been added to the list; namely, the American Landrace and the Palouse. The American Landrace, which was formally established in 1950, was started with descendants of Danish Landrace boars and sows which were imported by the U. S. Department of Agriculture in cooperation with the Iowa Agricultural Experiment Station in 1934. Imported Swedish and Norwegian Landrace animals were added in 1954 to provide a broader basis for selection. The growing popularity of this relatively new breed is indicated by the fact that last year it ranked third in total number of registrations. The Palouse was developed at the Washington State College of Agriculture, Pullman, Washington, from crosses started in 1945 between representatives of Danish Landrace hogs and Chester White.

Results of an exploratory test recently conducted on the preservation of swine semen for use in artificial insemination emphasize the possibilities of this method of dissemination of superior germ plasm in efforts to improve the over-all quality of the hog population. Boar semen collected and preserved in Norway was shipped by air to the Agricultural Research Center, Beltsville, Maryland, late in 1956 to test the keeping qualities of the semen. Between 30 and 40 hours elapsed from the time the semen was collected to the time the sows were inseminated. Eleven of the 24 sows inseminated or approximately 46 percent farrowed litters of strong, healthy pigs indicating that artificial insemination may become a valuable tool in swine breeding programs. The greatest limitations in applying it to advantage at the present time probably are the lack of adequate records concerning boars which possess truly superior germ plasm, and second, the lack of adequate methods for inducing ovulation in sows whenever it becomes necessary to use the available semen.

